

## WHAT IS CLAIMED IS:

1                   1.       A method for investigating an image set of geophysical data distributed  
2 over a first  $N$ -dimensional volume where  $N \geq 2$ , the method comprising:

3                   selecting a subvolume of a target set of geophysical data distributed over a  
4 second  $N$ -dimensional volume, the subvolume enclosing a known feature of interest; and  
5                   at each of a plurality of positions within the first  $N$ -dimensional volume,  
6 calculating a cross-correlation between the data distributed within the subvolume and  
7 corresponding data distributed in the first  $N$ -dimensional volume about the each of the  
8 plurality of positions.

1                   2.       The method recited in claim 1 further comprising displaying for a user  
2 a distribution of results of calculating the cross-correlation throughout the first  $N$ -dimensional  
3 volume.

1                   3.       The method recited in claim 1 further comprising:  
2                   modifying the subvolume in accordance with a user instruction; and  
3                   at each of a plurality of positions within the first  $N$ -dimensional volume,  
4 calculating a cross-correlation between the data distributed within the modified subvolume  
5 and corresponding data distributed in the first  $N$ -dimensional volume about the each of the  
6 plurality of positions.

1                   4.       The method recited in claim 3 wherein modifying the subvolume  
2 comprises changing a size of the subvolume.

1                   5.       The method recited in claim 3 wherein modifying the subvolume  
2 comprises changing a shape of the subvolume.

1                   6.       The method recited in claim 1 wherein:  
2                   each of the image set and the target set consists of real data, the method further  
3 comprising respectively transforming the real data of the image and target sets to complex  
4 data by performing a Hilbert transform of the real data; and  
5                   calculating the cross-correlation comprises calculating a complex cross-  
6 correlation between the transformed data distributed within the subvolume and corresponding  
7 transformed data distributed in the first  $N$ -dimensional volume about the each of the plurality  
8 of positions.

- 1                    7.        The method recited in claim 6 further comprising calculating an  
2 amplitude envelope and phase distribution from the complex cross-correlation over the first  
3  $N$ -dimensional volume.
- 1                    8.        The method recited in claim 1 wherein:  
2 each of the image set and the target set consists of real data; and  
3 calculating the cross-correlation comprises calculating a real cross-correlation.
- 1                    9.        The method recited in claim 1 further comprising normalizing the data  
2 distributed within the subvolume over the subvolume prior to calculating the cross-  
3 correlation.
- 1                    10.      The method recited in claim 1 wherein  $N = 3$ .
- 1                    11.      The method recited in claim 1 wherein  $N = 4$ .
- 1                    12.      The method recited in claim 1 wherein the image and target sets  
2 comprise seismic data.
- 1                    13.      The method recited in claim 1 wherein the image and target sets  
2 comprise mathematical transforms of seismic data.
- 1                    14.      The method recited in claim 1 wherein the image and target sets  
2 comprise prestack data.
- 1                    15.      The method recited in claim 1 wherein the image set is the target set.
- 1                    16.      The method recited in claim 1 wherein the subvolume is a  
2 parallelepiped.
- 1                    17.      A method for investigating an image set of real geophysical data  
2 distributed over a first  $N$ -dimensional volume where  $N \geq 2$  according to a known feature of  
3 interest identified in a target set of real geophysical data distributed over a second  $N$ -  
4 dimensional volume, the method comprising:  
5                    transforming the real geophysical data of the first  $N$ -dimensional volume to  
6 complex data by performing a Hilbert transform on the real geophysical data of the first  $N$ -  
7 dimensional volume;

8                   transforming the real geophysical data of the second  $N$ -dimensional volume to  
9 complex data by performing a Hilbert transform on the real geophysical data of the second  $N$ -  
10 dimensional volume;

11                   selecting a subvolume of the target set that encloses the known feature of  
12 interest in accordance with a user instruction; and

13                   at each of a plurality of positions within the first  $N$ -dimensional volume,  
14 calculating a complex cross-correlation between the transformed data within the subvolume  
15 and corresponding transformed data distributed in the first  $N$ -dimensional volume about the  
16 each of the plurality of positions.

1                   18.     The method recited in claim 17 further comprising:

2                   modifying the subvolume in accordance with another user instruction; and

3                   at each of a plurality of positions within the first  $N$ -dimensional volume,

4 calculating a complex cross-correlation between the transformed data within the modified  
5 subvolume and corresponding transformed data distributed in the first  $N$ -dimensional volume  
6 about the each of the plurality of positions.

1                   19.     The method recited in claim 17 further comprising normalizing the

2 transformed data distributed within the subvolume over the subvolume prior to calculating

3 the complex cross-correlation.

1                   20.     The method recited in claim 17 wherein the image set is the target set.

1                   21.     A computer-readable storage medium having a computer-readable

2 program embodied therein for directing operation of a computer system including an input

3 device, a processor, and a display device, wherein the computer-readable program includes

4 instructions for operating the computer system for investigating geophysical data in

5 accordance with the following:

6                   receiving, with the input device, an image set of geophysical data distributed  
7 over a first  $N$ -dimensional volume where  $N \geq 2$ ;

8                   receiving, with the input device, a target set of geophysical data distributed  
9 over a second  $N$ -dimensional volume;

10                   receiving, with the input device, a first user instruction identifying a  
11 subvolume of the target set that encloses a known feature of interest; and

12                   calculating, with the processor at each of a plurality of positions within the  
13 first  $N$ -dimensional volume, a cross-correlation between the data distributed within the  
14 subvolume and corresponding data distributed in the first  $N$ -dimensional volume about the  
15 each of the plurality of positions.

1                   22.     The computer-readable storage medium recited in claim 21 wherein  
2 the computer-readable program further includes instructions for displaying, for a user with  
3 the display device, a distribution of results of calculating the cross-correlation throughout the  
4 first  $N$ -dimensional volume.

1                   23.     The computer-readable storage medium recited in claim 21 wherein  
2 the computer-readable program further includes:  
3                   instructions for receiving, with the input device, a second user instruction to  
4 modify the subvolume; and  
5                   instructions for calculating, with the processor at each of a plurality of  
6 positions within the first  $N$ -dimensional volume, a cross-correlation between the data  
7 distributed within the modified subvolume and corresponding data distributed in the first  $N$ -  
8 dimensional volume about the each of the plurality of positions.

1                   24.     The computer-readable storage medium recited in claim 21 wherein:  
2                   each of the image set and the target set consists of real data, the computer-  
3 readable program further including instructions for respectively transforming the real data of  
4 the image and target sets to complex data by performing a Hilbert transform of the real data;  
5 and  
6                   the instructions for calculating the cross-correlation comprise instructions for  
7 calculating a complex cross-correlation between the transformed data distributed within the  
8 subvolume and corresponding transformed data distributed in the first  $N$ -dimensional volume  
9 about the each of the plurality of positions.

1                   25.     The computer-readable storage medium recited in claim 24 wherein  
2 the computer-readable program further includes instructions for calculating an amplitude  
3 envelope and phase distribution from the complex cross-correlation over the first  $N$ -  
4 dimensional volume.

1                    26.     The computer-readable storage medium recited in claim 21 wherein  
2     the computer-readable program further includes instructions for normalizing, with the  
3     processor, the data distributed within the subvolume prior to calculating the cross-correlation.